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New records of *Elasmus* (Hymenoptera, Eulophidae) species from Barrow Island, Western Australia

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Abstract

Eleven species of *Elasmus* are recorded from Barrow Island in northern Western Australia, including nine not previously recorded for Western Australia. *Elasmus curticornis* **sp. n.** is described as new to science.

Keywords

north-western Australia, parasitic wasps, range extension, Chalcidoidea, Eulophinae

Introduction

The Chalcidoidea fauna of north-western Australia remains poorly-known and few species have been previously recorded from the area. *Elasmus* Westwood 1833 is a very distinctive genus of Chalcidoidea with over 200 species described worldwide (Noyes 2012; Verma et al. 2002; Yefremova and Strakhova 2010). *Elasmus* species are readily distinguished from most other Chalcidoidea by their enlarged discus-like hind coxae. Because of their morphological distinctiveness, many authors have placed *Elasmus* in its own monogeneric family within the Chalcidoidea. However, Gauthier et al. (2000) demonstrated that it is better placed within the subfamily Eulophinae of the Eulophidae.

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Fifty-eight species of *Elasmus* were recognised in Australia by Riek (1967), including five species attributed to the genus *Austelasmus* Riek 1967. However, the latter were synonymised with *Elasmus* by Burks in Krombein et al. (1979). A further species was subsequently described by Naumann and Sands (1984). All species treated by Riek (1967) were recorded only from eastern Australia, from Queensland to Victoria, with three exceptions. These were *Elasmus ero* Girault 1920 and *Elasmus lividus* Girault 1913 from southern Western Australia and *Elasmus cyaneus* Girault 1912 from South Australia. Naumann and Sands (1984) reared *Elasmus bellicaput* Girault 1923 and *Elasmus broomensis* Naumann & Sands 1984 from specimens of cotton bollworm *Pectinophora gossypiella* (Saunders 1843). These were collected in Broome and are the only published records to date of *Elasmus* from northern Western Australia.

In general, northern Western Australia is poorly studied in terms of terrestrial invertebrates. However, since 2005, terrestrial invertebrates from over 20 orders have been surveyed regularly and recorded in detail on Barrow Island, an island off the coast of northern Western Australia (Callan et al. 2011). Barrow Island has been the subject of a long history of conservation and industrial custodianship as it is a Class 'A' nature reserve as well as Australia's longest running and largest onshore oil field. Currently, it is being utilised as a hub for the development and processing of Australia's offshore gas reserves by Chevron and its associates within the Gorgon Project (see acknowledgements). As a result of rigorous environmental impact assessment requirements, extensive surveys of flora and fauna have been carried out on the island. The surveys on Barrow Island possibly represent one of the most comprehensive records of terrestrial invertebrates in north-western Australia.

A large percentage of the invertebrate fauna recorded for the island represents undescribed species and many will remain so for years to come. A number of publications have described new species from specimens from Barrow Island (Fletcher 2008; Framenau 2011; Mound and Minaei 2007; Zhang et al. 2009) and it is hoped that species descriptions will continue to occur. Herewith, we present data from Barrow Island on this charismatic genus of chalcidoid wasp.

Methods

Barrow Island is approximately 234 km^2 in extent and is located about 60 km off the coast of Western Australia. The island is within the subtropical region of Australia and is characterised by wet summers (December to March) and cool dry winters (May to September). Annual rainfall is not consistent and in a given year, the island can receive no rainfall at all. Its flora is affiliated with the arid zones of the Carnarvon Basin and the Pilbara Bioregions and is dominated by hummock grasses (*Triodia* spp.) (Buckley 1983). Surveys were undertaken in two seasons in 2006 in native vegetation sites and in 2006 and 2007 at disturbed sites throughout the island. The results have been reported in Callan et al. (2011). A further study was commenced in 2009 and continues today targeting a different complement of sites.

A variety of collection methods were used as all terrestrial invertebrates were to be sampled. However, the majority of *Elasmus* specimens were collected mechanically using a modified leaf blower machine in suction mode. Species collected were identified using the key given in Riek (1967). Specimens were photographed mounted on points or in ethanol using a Leica M205C microscope and DFC500 camera, or Nikon SMZ1500 microscope and DS-Fi1 camera. Measurements were taken using the NIS-Elements D 4.00.03 programme for the Nikon SMZ1500 microscope.

Morphological terms used herein differ from Riek (1967) but conform with Bouček (1988) in that the anellus is not counted as part of the funicle. Abbreviations used below include: OC: minimum distance between posterior ocellus and the occipital carina; OD: ocellus diameter; OOL: minimum distance between posterior ocellus and adjoining compound eye; POL: distance between posterior ocelli.

Specimens are currently held by J. Majer, Curtin University; the type specimens of *Elasmus curticornis* sp. n. will be deposited in the Western Australian Museum, Perth, Australia.

Results

All species listed below were identified from female specimens collected on Barrow Island. The GPS coordinates of the localities where specimens were collected are listed in Table 1. Numerous male *Elasmus* specimens, representing several species, were also among the material collected. Unfortunately, our knowledge of the Australian *Elasmus* fauna is currently inadequate for males to be associated with their corresponding females (Riek 1967), unless collected in direct association. Because of the largely mechanical nature of the collection methods used in the current survey, such association could not generally be assumed, and many samples contained females of multiple species.

For convenience, species collected from Barrow Island are here organised into an identification key to emphasise distinguishing features, with figures provided for each species at the appropriate position in the key. Further notes on individual species have been provided after the key. A more extensive key to Australian *Elasmus* species can be found in Riek (1967).

Key to Barrow Island species of *Elasmus* (based on females)

1 Scutellum mostly light-coloured **2**
– Scutellum dark..... **4**
2 Mesoscutum mostly light-coloured ..... ***formosus nakomara*** **Girault**
– Mesoscutum extensively dark..... **3**
3 Mesoscutum dark medially, light-coloured laterally.... ***arumburinga*** **Girault**
– Mesoscutum entirely dark..... ***auratiscutellum*** **Girault**
4 Antennae with at least one funicle segment as broad as or broader than long... **5**

–	Antennae with all funicle segments distinctly longer than broad **7**
5	Fore coxae entirely dark; gaster without extensive red markings ..... ***neofunereus* Riek**
–	Fore coxae pale at least in distal half; gaster with extensive red coloration ... **6**
6	Fore coxa entirely pale; hind coxa pale in distal half; hind femur entirely pale ..... ***flavipropleurum* Girault**
–	Fore coxa basally dark; hind coxa almost entirely dark; hind femur extensively dark ..... ***curticornis* sp. n.**
7	Head mostly bright yellow ..... ***bellicaput* Girault**
–	Head entirely dark **8**
8	Posterior pair of scutellar bristles much larger than anterior pair, extending well past end of metanotum; gaster extensively red with at least segments 2–3 entirely red in dorsal view ..... ***ero emma* (Girault)**
–	Posterior pair of scutellar bristles little longer than anterior pair, not or only just extending past end of metanotum; gaster entirely dark or almost entirely dark in dorsal view **9**
9	Fore coxae pale in distal half ..... ***broomensis* Naumann & Sands**
–	Fore coxae entirely dark **10**
10	Apex of hind femur narrowly pale ..... ***tenebrosus* Riek**
–	Hind femur entirely dark ..... ***funereus* Riek**

Table 1. Collection data for female *Elasmus* specimens on Barrow Island. Specimens from 2006 were collected by S. Callan and R. Graham; those from 2007 were collected by S. Callan and K. Edwards; subsequent specimens were collected by N. Gunawardene and C. Taylor. Most *Elasmus* species on Barrow Island were collected from multiple localities. Only *Elasmus arumburinga* and *Elasmus broomensis* were collected from only one locality on the island.

Species	Locality	Easting	Northing	Date	No. of specimens
E. arumburinga	Gas Plant Site	115°27'10"E	20°47'33"S	19–29 September 2011	1
E. auratiscutellum	Accommodation Camp	115°26'39"E	20°49'35"S	6 May 2006	1
E. auratiscutellum	Airport	115°24'26"E	20°51'55"S	6 May 2006	1
E. auratiscutellum	Airport	115°24'25"E	20°51'54"S	19–29 September 2011	1
E. auratiscutellum	Gas Plant Site	115°27'10"E	20°47'33"S	19–29 September 2011	6
E. auratiscutellum	Near Gas Plant Site GP9	115°26'59"E	20°47'59"S	25 September 2006	1
E. bellicaput	Gas Plant Site	115°27'10"E	20°47'33"S	19–29 September 2011	1
E. bellicaput	Near Gas Plant Site CC2	115°26'24"E	20°49'3"S	25 September 2006	1
E. bellicaput	Northern Sector HDD	115°25'13"E	20°41'34"S	14–24 March 2011	2

Species	Locality	Easting	Northing	Date	No. of specimens
E. broomensis	Barge Landing	115°28'20"E	20°43'29"S	6 May 2006	1
E. curticornis	Barge Landing	115°28'19"E	20°43'29"S	14–24 March 2011	1
E. curticornis	Northern Sector HDD	115°25'13"E	20°41'34"S	14–24 March 2011	1
E. ero emma	Accommodation Camp	115°26'39"E	20°49'35"S	14–24 March 2011	1
E. ero emma	Gas Plant Site	115°27'10"E	20°47'33"S	19–29 September 2011	1
E. ero emma	Northern Sector X81	115°25'19"E	20°44'22"S	9–23 November 2009	1
E. flavipropleurum	Accommodation Camp	115°26'39"E	20°49'35"S	25 September 2006	4
E. flavipropleurum	Accommodation Camp	115°26'15"E	20°49'2"S	19–29 September 2011	2
E. flavipropleurum	Airport	115°24'26"E	20°51'55"S	1–8 March 2010	1
E. flavipropleurum	Gas Plant Site	115°27'10"E	20°47'33"S	8–17 November 2010	1
E. flavipropleurum	Gas Plant Site	115°27'10"E	20°47'33"S	14–24 March 2011	1
E. flavipropleurum	Gas Plant Site	115°27'10"E	20°47'33"S	19–29 September 2011	7
E. flavipropleurum	Near Gas Plant Site GP2	115°27'27"E	20°47'38"S	25 September 2006	5
E. formosus nakomara	Accommodation Camp	115°26'39"E	20°49'35"S	19–29 September 2011	1
E. formosus nakomara	Central Eastern Sector	115°25'55"E	20°47'47"S	9–23 November 2009	2
E. formosus nakomara	Gas Plant Site	115°27'10"E	20°47'33"S	19–29 September 2011	1
E. formosus nakomara	Near Gas Plant Site GP3	115°27'25"E	20°47'9"S	15 March 2006	1
E. formosus nakomara	Near Gas Plant Site GP4	115°27'33"E	20°47'3"S	25 September 2006	1
E. formosus nakomara	Northern Sector 72M	115°26'24"E	20°42'30"S	9–23 November 2009	1
E. formosus nakomara	Northern Sector HDD	115°25'13"E	20°41'34"S	19–29 September 2011	2
E. funereus	Barge Landing	115°26'39"E	20°49'35"S	1–8 March 2010	1
E. funereus	Barge Landing	115°28'19"E	20°43'29"S	14–24 March 2011	1
E. funereus	Barge Landing	115°28'19"E	20°43'29"S	19–29 September 2011	1
E. funereus	Central Eastern Sector	115°25'58"E	20°46'51"S	6 May 2006	1
E. funereus	Central Eastern Sector	115°25'55"E	20°47'47"S	9–23 November 2009	1
E. funereus	Central Sector	115°23'37"E	20°47'5"S	6 May 2006	1
E. funereus	Gas Plant Site	115°27'10"E	20°47'33"S	19–29 September 2011	4
E. neofunereus	Barge Landing	115°28'20"E	20°43'29"S	6 May 2006	2
E. neofunereus	Near Accommodation Camp	115°26'34"E	20°49'26"S	25 November 2006	1

Species	Locality	Easting	Northing	Date	No. of specimens
E. neofunereus	Near Gas Plant Site CC2	115°26'24"E	20°49'3"S	25 November 2006	1
E. tenebrosus	Barge Landing	115°28'19"E	20°43'29"S	14–24 March 2011	1
E. tenebrosus	Central Eastern Sector	115°25'58"E	20°46'51"S	6 May 2006	1
E. tenebrosus	Gas Plant Site	115°27'10"E	20°47'33"S	19–29 September 2011	2
E. tenebrosus	Near Accommodation Camp	115°26'34"E	20°49'26"S	6 May 2006	3
E. tenebrosus	South-eastern Sector	115°25'13"E	20°49'55"S	1 May 2007	2

Elasmus arumburinga Girault, 1920

Fig. 1

Comments. This species has previously been recorded from Queensland and Victoria (Riek 1967).

Figure 1. *E. arumburinga*, female, September 2011. Lateral view **A** dorsal view **B** antenna **C**.

Elasmus auratiscutellum Girault, 1915

Fig. 2

Comments. This species was previously described from Gordonvale in Queensland (Riek 1967). Riek's (1967) treatment of this species is contradictory as the species key states that the mesoscutum is dark while the species description indicates that it is light. Girault's (1915) original description implies that the mesoscutum is dark. *Elasmus auratiscutellum* has a similar colour pattern to *E. splendidus* Girault 1912, but has the scutellum almost entirely yellow while *E. splendidus* has the scutellum dark with yellow margins. The pedicel of *E. splendidus* is less than half the length of the first funicular segment while that of *E. auratiscutellum* is nearly as long as the first funicular segment. Some variation in coloration is visible among the specimens available: most specimens have the pronotum entirely dark, but two specimens have the lateral panels of the pronotum yellow.

Figure 2. *E. auratiscutellum*, airport, May 2006. Lateral view **A** dorsal view **B** antenna **C**.

Elasmus bellicaput Girault, 1923

Comments. This species was previously recorded from Broome in northern Western Australia by Naumann and Sands (1984). A specimen of this species was included by Stevens et al. (2007) among the figured examples of Eulophidae.

Elasmus broomensis Naumann & Sands, 1984

Fig. 3

Comments. This species was described from Broome in northern Western Australia by Naumann and Sands (1984).

Figure 3. *E. broomensis*, May 2006. Lateral view **A** dorsal view **B** antenna **C**.

Elasmus curticornis sp. n.

urn:lsid:zoobank.org:act:B14EC723-18E2-4AFA-B69F-F4B6B957B96B
http://species-id.net/wiki/Elasmus_curticornis

Fig. 4

Holotype. 1 ♀, Barrow Island, northern sector HDD, N. Gunawardene, C. Taylor, 14–24 March 2011, sticky trap.

Paratype. 1 ♀, barge landing, N. Gunawardene, C. Taylor, 14–24 March 2011, suction.

Etymology. From the Latin *curtus*, shortened, and *cornu*, a horn, in reference to the short antennae of this species, as well as by analogy to the similar species *E. brevicornis* Gahan 1922.

Description. *Body length*. 1.48–2.13 mm.

Coloration. Head and mesosoma blackish with green sheen, except antenna, mandibles and base of tegula cream, dorsellum translucent. Gaster primarily orange, except T1 black, T4 with or without posterolateral dark spots meeting medially, posterior part of T5 to end of gaster black or T5 with transverse dark stripe and T6 to end of gaster dark, S6 to end of gaster black. Leg 1 with base of coxa black, remainder yellow except basal infuscation on femur; legs 2 and 3 each with coxae black except distal ends yellow, trochanters yellow, femora mostly brown except proximal and distal ends yellow, tibiae and tarsi yellow.

Head. Slightly narrower than mesosoma; in dorsal view 2.0 times wider than long; in frontal view slightly (1.1 times) wider than high. Vertex and frons with dense piliferous punctures, with interspaces on frons subequal to diameter of punctures. Ocellar triangle about twice as long as wide, POL:OOL 2.3–2.5:1, OD:OOL 0.3–0.4:1, OC:OD 0.8–0.9:1. Compound eye 1.5–2.1 times as high as wide in lateral view; inner margins of compound eyes straight to slightly concave, frons minimum width 0.7 times total head width. Malar space 0.4–0.5 times eye height; lower margin of toruli 2.1–2.5 times their diameter from lower margin of face, about in line with lower margin of eyes. Each mandible with seven teeth.

Antenna (Figure 4B, C). Scape 0.5 times as long as pedicel and flagellum combined, lengths of scape and of pedicel and flagellum combined 0.6–0.7 times and 1.0–1.2 times compound eye height; pedicel 1.4–1.8 times as long as wide, 1.3 times length of funicle 1; funicle 1 subtriangular, 0.9–1.0 times as long as wide; funicle 2 and 3 each shorter than (0.8 times and 0.8–0.9 times length of, respectively) funicle 1, funicle 2 0.6–0.7 times and funicle 3 0.6 times as long as wide; clava 1.4–1.5 times as long as wide, 2.3–2.8 times as long as and 1.3 times as wide as funicle 3, clava 3 triangular.

Mesosoma (Fig. 4D, E). 1.5–1.7 times longer than wide. Mesoscutum 0.9 times as long as wide, densely covered with piliferous punctures; posterior margin of mesoscutum concave. Scutellum 0.9 times as long as wide, finely reticulate, setae absent except elongate setae at anterolateral and posterolateral corners, anterior and posterior pairs of setae of similar length, posterior setae not extending beyond apex of dorsellum. Dorsellum length 0.7 times basal width.

Wings. Hyaline. Forewing (Fig. 4F, G) 1.4–1.5 times length of head and mesosoma combined, 3.3–3.6 times as long as wide; isolated subcubital line of setae present; postmarginal vein subequal in length to stigmal vein. Hind wing 0.9 times length of forewing, 5.1 times as long as wide.

Legs. Mid femur with stout apical posterolateral seta 0.2–0.3 times length of tibia. Hind tibia with dorsal pattern of black setae demarking four diamonds anterolaterally and three diamonds posterolaterally.

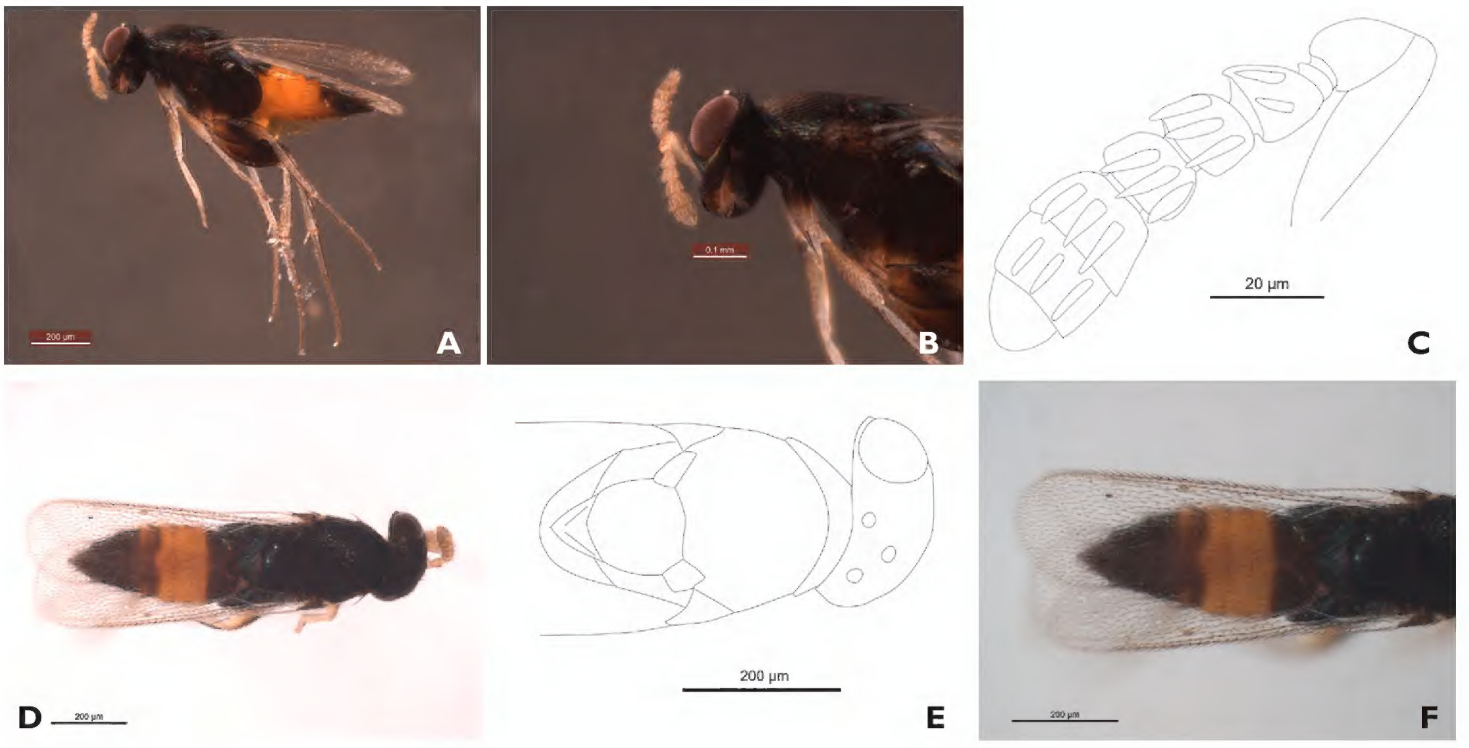

Figure 4. *Elasmus curticornis*, holotype. Lateral view **A** close-up of head **B** antenna, diagram (setae omitted) **C** dorsal view **D** dorsal view, diagram (E) forewing **F** forewing diagram showing setal pattern **G**.

Gaster. Gaster 0.8–1.1 times length of head and thorax combined, 2.1–2.3 times as long as wide, not produced; posterior margin of T6 straight.

Comments. The distinctive quadrate antennae of this species, with all funicular segments broader than long, distinguish it from most other species of *Elasmus* except the Asian species *Elasmus brevicornis* Gahan 1922 and *Elasmus philippinensis* Ashmead 1904 and the Australian *Elasmus concinnus* Riek 1967. *Elasmus philippinensis* has a brown-black flagellum, with only the scape yellowish (Ashmead 1904). *Elasmus brevicornis* and *E. concinnus* both have notably less extensive light coloration on the gaster. The gaster of *E. concinnus* is dorsally almost entirely dark except for a light cross-band at the apex of T2 (Riek 1967), while that of *E. brevicornis* is light dorsally at the apex of T1, T2 and sometimes T3 (Mani and Saraswat 1972; Verma et al. 2002; Yefremova

and Strakhova 2010) and may sometimes be entirely dark brown to black (Verma et al. 2002). In contrast, the gaster of *E. curticornis* is light from the apex of T1 to T4 or T5. Laterally, the gasters of *E. brevicornis* and *E. concinnus* are light over at most a third (Mani and Saraswat 1972; Riek 1967) while that of *E. curticornis* is light over at least two-thirds. Also, *E. brevicornis* has POL 1.5 times OOL (Yefremova and Strakhova 2010), as opposed to about 2.5 times in *E. curticornis*. *Elasmus concinnus* has the flagellum dark above and the first claval segment distinctly shorter than the third funicle (Riek 1967); *E. curticornis* has the flagellum more evenly pale, and the first claval segment and third funicle are subequal in length.

Elasmus ero emma (Girault, 1940)

Fig. 5

Comments. *Elasmus ero emma* was previously only known from Capella in central Queensland, but the type subspecies *Elasmus ero ero* has previously been recorded from Bunbury in southern Western Australia (Riek 1967). Some minor variation in colour pattern is visible in the available specimens: the specimen collected in November 2009 has the fore coxae almost entirely dark, as well as more extensive dark coloration of the dorsum of the gaster, with transverse dark stripes on the posterior margins of segments 4 on.

Figure 5. *E. ero emma*, March 2011. Lateral view **A** dorsal view **B** antenna **C**.

Elasmus flavipropleurum Girault, 1940

Fig. 6

Comments. This species was originally described from Gordonvale in northern Queensland (Riek 1967). Specimens may vary in the degree of dark coloration on the gaster; several specimens are almost entirely dark dorsally except for the posterior margins of most segments, while remaining predominantly orange laterally.

Figure 6. *E. flavipropleurum*, March 2010. Lateral view **A** dorsal view **B** antenna **C**.

Elasmus formosus nakomara Girault, 1920

Fig. 7

Comments. This species has been recorded from a number of localities in eastern Queensland (Riek 1967).

Figure 7. *E. formosus nakomara*, November 2009. Lateral view **A** dorsal view **B** antenna **C**.

Elasmus funereus Riek, 1967

Fig. 8

Comments. This species was originally described from a number of localities in Queensland, New South Wales and the Australian Capital Territory (Riek 1967).

Figure 8. *E. funereus*, March 2010. Lateral view **A** dorsal view **B** antenna **C**.

Elasmus neofunereus Riek, 1967

Fig. 9

Comments. This species was described from Griffith in New South Wales (Riek 1967).

Figure 9. *E. neofunereus*, May 2006. Lateral view **A** dorsal view **B** antenna **C**.

Elasmus tenebrosus Riek, 1967

Fig. 10

Comments. This species was described from near Bourke in New South Wales. Riek (1967) described this species as having the gaster entirely dark; however, specimens from Barrow Island are reddish laterally on segments 2–5. This reddish coloration is more marked in some specimens than others, and may be little more than a reddish shading. In other features, specimens correlate with Riek's (1967) description, and we feel confident in assigning them to Riek's species.

Figure 10. *E. tenebrosus*, May 2007. Lateral view **A** dorsal view **B** antenna **C**.

Discussion

To date, eleven species of *Elasmus* have been recorded for the island and for eight of the species, the current records represent notable range extensions. Many chalcid species are known to have broad, even cosmopolitan, distributions (Bouček 1988). The fact that many of the *Elasmus* species now listed for Barrow Island occur on the other side of the continent demonstrates the large gap in collection effort for the north-west of Australia. Much of Barrow Island's invertebrate fauna is most likely shared with the mainland, especially in terms of more motile groups. Ants have

been well collected for the region and taxonomic expertise is available for this family of wasp relatives. The ant species from Barrow Island are all found on mainland Western Australia. However, comparisons of other invertebrate taxa from Barrow at a regional or continental scale are impeded by the lack of surveys carried out in the north-western part of the state. Its remoteness and the lack of resources for biological surveys in this part of the world mean that much of the fauna in the north-west still remains unknown. The other issue is the lack of current taxonomic work being carried out on these groups. Out of the 363 wasp morphospecies listed for Barrow Island, only *Elasmus* has been successfully taken to species with the help of Riek (1967). The majority of the remaining wasps have been identified only to family. Currently, a few other families are being analysed further and will hopefully yield species identifications or new species descriptions.

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